UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service

-
ARS 44-25
June 1958

The Nutrient Losses and Feeding Values of Wilted and Direct Cut Forages Stored in Bunker and Tower Silos[1]

C. H. Gordon, C. G. Melin, W. C. Jacobson, H. G. Wiseman, E. A. Kane
and J. C. Derbyshire, Dairy Cattle Research Branch

and

J. R. McCalmont and D. T. Black

Agricultural Engineering Research Division
Beltsville, Maryland

While the usefulness of chemical preservatives and wilting for producing high quality silage has been repeatedly demonstrated, the relative effectiveness of these procedures for high-moisture hay crop silages has not been well established. Similarly, the quality and efficiency relationships of silages made in tower and bunker silos have not been established. This experiment was planned to compare the nutrient losses and feeding value of silages stored in tower and bunker silos as well as silages made by wilting and the addition of sodium meta-bisulfite.

Three forages from a 1956 first cutting crop consisting mainly of orchardgrass were harvested simultaneously from the same fields for filling three silos. Forage stored in silo M-1 (10' x 25' concrete tower) was wilted to an average moisture content of 70%. Forages stored in silo M-3 (10' x 25' concrete tower) and silo B-1 (15' x 66' x 8' bunker) were direct cut harvested and treated with about 8 pounds of sodium meta-bisulfite (SMB) per ton. Forage harvesters were set for a 5/16 to 3/8 inch cut. SMB was applied at the blower for silo M-3 through a metering device. SMB was applied manually after each load was spread in the bunker.

Filling was started on May 2, but was interrupted by bad weather after storing two loads in silo M-3. A temporary plastic seal prevented spoilage in this silo until filling was started again on May 7. Filling was completed during the May 7-11 period. A neoprene-nylon blanket was applied to the surface silage of B-1 silo on May 11 and weighted with a 2-3 inch layer of sawdust. Silos M-1 and M-3 were covered with sheets of polyethylene weighted with non-experimental forage. An arrangement of guttering and flow meters was utilized to measure the seepage from all three silos.

1/ Paper presented at the annual meeting of the American Dairy Science Association, June 17-19, 1958 at North Carolina State College, Raleigh, North Carolina.

Agriculture-Washington

All stored materials and the resulting silages and seepages were weighed and sampled for chemical analysis. Silage temperatures were measured in silos M-1 and M-3 by thermocouples located in the center of the silo at 1/2, 6, 12, 18 and 24 feet above the silo floor.

The silos were opened and feeding commenced after six months storage. The resulting silages were sampled daily. Fresh 5-day composite samples were analyzed for dry matter (toluene distillation) pH, sugar, carotene, crude protein, ammoniacal nitrogen and organic acids. Dried 20-day composites were analyzed for the remaining crude constituents.

Feeding values were estimated with four concurrent 3x3 Latin square feeding trials, using 12 milking dairy cows during a 120 day period. The rations consisted of silage to the limits of appetite and a concentrate mixture fed according to milk production. Initial grain feeding levels were individually based on a grain:milk ratio of about 1:4. Changes in grain feeding thereafter were based on the percentage decline in FCM production of the entire group.

Dry matter digestibility was determined by the total collection method, after completion of the feeding trial.

Results and Discussion

Average daily temperatures for the silages stored in towers starting the day after filling was completed are presented in Figure 1. Temperatures in the wilted silage increased more rapidly than in the direct-cut silage reaching a peak of about 80° F. five days after storage after which they remained in the 70-78 degree range. The direct-cut silage reached an average temperature of 80° F. about 20 days after storage and thereafter remained in a 78-86 degree range. The relatively low temperatures in both silages indicated that air had been quite successfully excluded.

Average initial and final chemical composition of the silages are presented in Table 1. The wilted forage was distinctly higher in dry matter and lower in carotene content when stored than the direct-cut forages. These differences were less marked after storage. Seepage from both direct-cut silages contributed to an increased dry matter content of the final silages. This effect was most marked in the direct-cut, tower stored, SMB treated silage. The higher percentage of sugar remaining in the SMB treated silages has often been reported and is usually explained as the result of restricted natural fermentation. The increase in concentration and amount of carotene is not understood but has been previously noted in other silages, particularly orchardgrass.

All silages were of good quality as indicated by pH, ammoniacal nitrogen and organic acid contents (Table 1). Bunker storage, however, resulted in a somewhat higher pH, while wilted silage had a higher concentration of all organic acids measured. The occurrence of 2.1% butyric acid in silage with a pH as low as 4.3 which was observed in the wilted silage is unusual.

Dry matter was preserved with about equal efficiency in tower stored wilted silage and the direct-cut bunker stored silage (Table 1). Dry matter preservation was least efficient in direct-cut tower stored silage with SMB by a considerable margin. The distribution of dry matter losses in each silo (Table 2) offers a partial explanation of these differentials. It may be noted that much more dry matter was lost through seepage in the direct-cut tower stored silage. Seepage loss was reduced by wilting in the other tower stored forage and by reducing the depth of the silage mass by about 2/3 in the case of bunker storage. Visible top spoilage, often a major source of loss in bunkers, was nearly eliminated by the sealing technique used. Spoilage was confined to an area adjacent to the upper part of the bunker sides.

Results of the feeding trial are presented in Table 3. Considerably greater amounts of silage dry matter were consumed from wilted silage than from the other two. This difference was highly significant and is considered to be indicative of the extent to which these silages could be utilized as the sole ration. Cows on wilted silage attained a somewhat higher level of TDN intake as indicated by calculated requirements.

Differences in FCM production were small. However, the higher production from the bunker stored silage as compared to similar silage stored in a tower was statistically significant at the 5% level. Differences in the regression of FCM production during the 11-40 day period following a ration change were small but highly significant. The positive regression (indicating a rise in production) occurring when cows were fed the tower stored SMB silage appears somewhat contradictory to the lower average FCM production. This may be explained by the marked tendency of cows to drop in production during the first 10 to 20 days on this silage ration and to recover from this drop during the remainder of the period. However, cows on the other rations exhibited a normal steady decline. The negative regression during the first 20 days following ration changes was markedly higher for the SMB tower stored silage.

Small weight gains were made on all rations; differences among groups being non-significant. Silage dry matter digestibility values were relatively high and essentially the same for all silages.

Summary

A direct comparison was made of the storage losses, chemical quality and feeding value of first cutting orchardgrass stored as wilted silage in a tower silo, direct-cut SMB treated silage stored in a tower silo and direct-cut SMB treated silage stored in a bunker silo. Top spoilage losses were minimized in all silos by the use of weighted plastic covers.

Under the conditions of this experiment, properly sealed bunker storage for direct-cut forage appeared to be somewhat superior to tower silo storage. All silages were of good chemical quality with pH values of 4.2 - 4.4. Higher seepage losses accounted for a large part of the greater total losses (22%) observed in the tower stored direct-cut silage. Total losses of the other two silages were about equal (14-15%). Dairy cows consumed the most dry matter from the wilted silage and produced the most milk from the bunker stored silage.

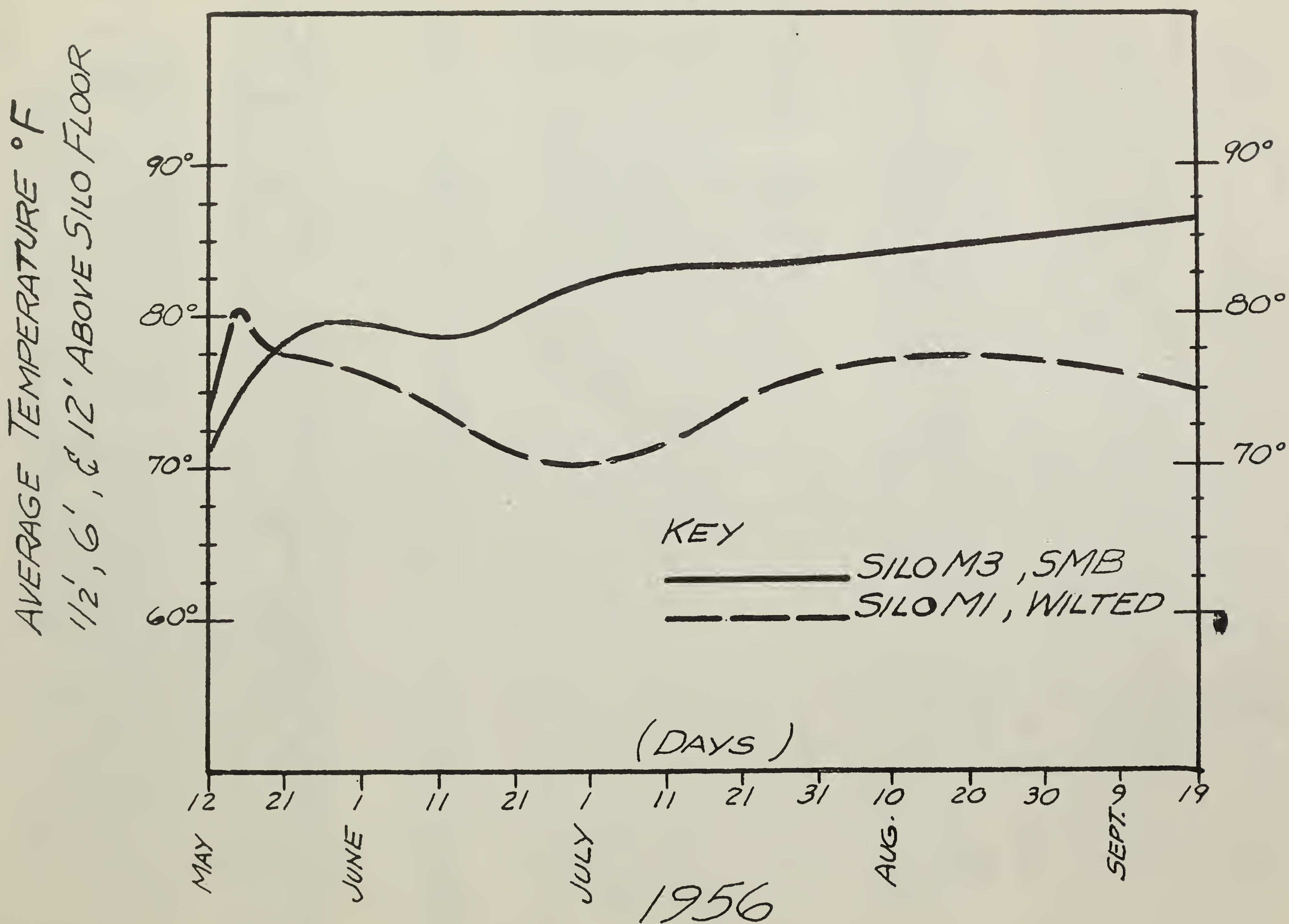

Figure 1. Average Temperature of Tower Stored Silage

Table 1

Average chemical composition of forages and silages and percentage of stored nutrients preserved for feeding

	Percentage Composition 1/						Percent of Stored Nutrients Preserved for Feeding		
	Forage Stored			Silage Fed					
	Wilted in tower	Bisulfite in tower	Bisulfite in bunker	Wilted in tower	Bisulfite in tower	Bisulfite in bunker	Wilted in tower	Bisulfite in tower	Bisulfite in bunker
Dry Matter	30.0	22.2	21.8	29.0	25.4	22.4	86.3	77.9	85.2
Crude Protein	12.8	13.6	13.5	14.4	13.5	14.2	96.7	77.4	89.9
Ether Extract	3.1	3.4	3.2	3.3	3.5	3.6	91.7	80.6	96.3
Crude Fiber	25.9	24.9	24.9	29.5	29.8	28.8	98.2	93.0	98.7
N.F.E.	49.4	47.4	47.9	42.7	43.1	42.5	74.6	70.8	75.6
Ash	8.8	10.6	10.6	10.2	10.1	10.9	99.5	73.9	87.7
Sugar	8.6	8.6	8.4	0.8	2.6	3.0	8.2	23.5	30.1
Carotene	163.7	199.3	194.2	215.6	275.5	236.1	113.6	107.7	103.6
pH				4.2	4.2	4.4			
Ammon. Nit.				12.5	10.1	9.7			
Butyric Acid				2.1	0.4	0.5			
Acetic Acid				1.9	1.2	1.5			
Propionic Acid				0.2	0.1	0.1			
Lactic Acid				5.2	4.2	3.8			

1/ Ammoniacal nitrogen expressed as percentage of total nitrogen, carotene as ug/gram of dry matter, all other constituents except pH expressed as percentage of dry matter.

Table 2

Distribution of Dry Matter Losses
(Percent of Stored Dry Matter)

Silage	Spoilage	Seepage	Invisible	Total
Wilted Tower	0	1.7	12.0	13.7
Bisulfite Tower	0	8.4	13.7	22.1
Bisulfite Bunker	0.5	3.8	10.5	14.8

Table 3

Results of Feeding Trial

	Silages		
	Wilted Tower	Bisulfite Tower	Bisulfite Bunker
Feed Dry Matter Consumed			
Pounds per cow per day			
Silage	23.34	20.47	20.06
Concentrates	5.71	5.76	5.70
Total	29.05	26.23	25.76
Pounds per 100 lb. liveweight per day			
Silage	2.34[4/][5/]	2.09[4/]	2.07[5/]
Concentrates	0.57	0.59	0.59
Total	2.91	2.67	2.66
Milk Production (FCM) Per Cow			
Average per day (lb.)	24.51	23.53[8/]	25.11[8/]
10 day regression[1/] (lb.)	-.35[6/]	+.96[6/][7/]	-.55[7/]
10 day regression[2/] (lb.)	-1.47	-2.26	-1.09
Ratio Grain:Milk	1:4.3	1:4.1	1:4.4
Liveweight Per Cow (lb.)			
Average	998	982	967
10 day regression[3/]	+15.4[9/]	+15.2[9/]	+9.7[9/]
Total Daily TDN Requirement, Calculated	21.2	20.7	19.2
Digestibility of Silage Dry Matter (%)	69.0	70.9	71.1

1/ Regression during 10 day time intervals ending 20, 30 and 40 days after ration changes.
2/ Regression during 10 day time intervals ending 10 and 20 days after ration changes.
3/ Regression of liveweight on 10 day time intervals at 20, 30 and 40 days after ration changes.
4/ Difference highly significant.
5/ " " "
6/ " " "
7/ " " "
8/ " significant.
9/ " not significant.